Set 3. Significant Figures and Calculations

Skill 3.01: Be able to round the result of a subtraction/addition calculation
Skill 3.02: Be able to round the result of a multiplication/division calculation
Skill 3.04: Be able to round the result of a calculation involving exact numbers
Skill 3.05: Be able to round the result of a chain calculation

Skill 3.01: Be able to round the result of a subtraction/addition calculation

Skill 3.01 Concepts

In addition and subtraction, the number of significant figures to the right of the decimal point in the final sum or difference is determine by the smallest number of significant figures to the right of the decimal point in any of the original numbers. Consider the following example:

89.332 ← three significant figures after the decimal point
+ 1.1 ← one significant figure after the decimal point
90.432 ← round off to 90.4

Because there is only one significant figure to the right of the decimal in the second number you should round to this digit in the final result.

Skill 3.01 Example 1

Carry out the following arithmetic operations and round the result to the correct significant figures:

(a) 11, 254.1 g + 0.1983 g	(b) 66.59 L – 3.113 L	(c) 123 mL + 1.006 mL - 2.6 mL
11254.1 + .1983 = 11254.2983 → 11254.3	66.59 − 3.113 = 63.477 → 63.48	123 + 1.006 − 2.6 = 121.406 → 121

Skill 3.01 Exercise 1

Skill 3.02: Be able to round the result of a multiplication/division calculation

Skill 3.02 Concepts

In multiplication and division, the number of significant figures in the final product or quotient is determined by the original number that has the smallest number of significant figures. The following example is illustrative:

2.8 x 4.5039 = 12.61092 ← round off to 13 because 2.8 only has 2 significant figures

Skill 3.02 Example 1

Do the following calculations and round to the correct significant figures:

(a) 1222g/2g	(b) 60.50 ft x 2.0000 ft	(c) 1000. in/5.0 in
1222 (4 s.f.) / 2 (1 s.f.) = 611 → 600	4 < 5; 121.0	4 / 2 = 200 (1 s.f.) → 200. (3 s.f.) → 2.0×10^2

Skill 3.02 Exercise 1

Skill 3.03: Be able to round the result of a calculation involving exact numbers

Skill 3.03 Concepts

An exact number is obtained from a definition or by counting numbers of objects and can be considered to have an infinite number of significant figures.

Skill 3.03 Example 1

Which of the following are examples of exact numbers?		
(a) There are 24 skittles	(b) mount rainier is 14, 442 feet high	(c) there are 2.54 cm in an inch
count Exact	measurement Not exact	2.54cm = 1 in Exact

Because exact numbers have an infinite number of significant figures you never round to them. For example if an object has a mass of 0.2786 g, then the mass of eight such objects is:

0.2786 g x 8 = 2.339 g

Notice, we DID NOT round to the product to one significant figure, because the number 8 is 8.00000..., by definition.

Skill 3.03 Example 2

One skittle is found to weigh 1.0 g. How much does 500 skittles weigh to the correct number of significant figures?
500 g 500. 5.0×10^2 Exact because its counted Do not round to Exact #'s

[Skill 3.03 Exercise 1]

Skill 3.04: Be able to round the result of a chain calculation

Skill 3.04 Concepts

A chain calculation is a calculation involving more than one step. The rule we will apply in this class is to always round to the measurement with the fewest significant figures. Consider the following example:

Suppose a student collected the following data and was asked to find the density of the object.

Volume of water in graduated cylinder: 20.1 mL
Volume of water in graduated cylinder with submerged object: 25.9 mL
Mass of object: 5.75 g

Step 1: calculate the volume of the object: 25.9 mL – 20.1 mL = 5.8 mL

Step 2: calculate the density (mass/volume): 5.75 g/5.8 mL = 0.9918 g/mL

Step 3: round the result to the appropriate significant figures: 0.992 g/mL

**Go back to the data, the worst measurement contains 3 significant figures, therefore, that is all that is allowed in the final reported value.

Skill 3.04 Example 1

A student is to the determine the density of an object using the following data:

Length of cube: 55. cm
Mass of cube: 0.201 g

Use the equations below to calculate the density of the object, then round to the appropriate significant figures

Volume of a cube = $(\text{Length})^3$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Density = $\frac{55 \times 55 \times 55\ g}{.201} = \frac{.201\ g}{(55 \times 55 \times 55)\ cm^3}$

$= .000001\underline{2}1$

$.000001\underline{2}$ 1.2×10^{-6}

Skill 3.04 Example 2

A student is to the determine the density of an object using the following data:

Length of the cube: 11 cm
Mass of the cube: 950. g

Density = $\frac{\text{mass}}{\text{volume}} = \frac{950\ g}{(11)^3} = .7137\ g/cm^3$

$.71\ g/cm^3$

Skill 3.04 Exercise 1